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SUBJECT MATTER INDEX OF APPLICATIONS FOR PATENTS.

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HEAT IN ITS MECHANICAL APPLICATIONS.

AT the Institution of Civil Engineers, the first of the six lectures on "Heat in its Mechanical Applications" was delivered on Thursday evening, the 15th of November, by Professor Osborne Reynolds, M.A., F.R.S., the subject being "The General Theory of Thermodynamics." The following is an abstract of the lecture:—

Thermodynamics was a very difficult subject. The reasoning involved was such as could only be expressed in mathematical language; but this alone would not prevent the leading facts and features of the subject being expressed in popular language. The physical theories of astronomy, light, and sound, involved even more mathematical complexities than thermodynamics, but these subjects had been rendered popular, and this to the great improvement of the theories.

What rendered the subject of thermodynamics so obscure, was that it dealt with a thing or entity (heat), which, although its effects could be recognised and measured, was yet of such a nature that its mode of operation could not be perceived by any of our senses. Had clocks been a work of nature; and had the mechanism been so small that it was absolutely imperceptible, Galileo, instead of having to invent a machine to perform a definite function, would have had, from the observed motions of the hands, to have discovered the mechanical principles and actions involved. Such an effort would have been strictly parallel to that required for the discovery of the mechanical principles, of which the phenomena of heat were the result.

In the imagined case of the clock, the discovery might have been made in two ways. By the scientific method; from the observed motion of the hands the fact that the clock depended on a uniform intermittent motion, would have led to the discovery of the principle of the uniformity of the period of vibrating bodies; and on this principle the whole theory of dynamics might have been founded. Such a theory of mechanics would have been as obscure, but not more obscure than the theory of thermodynamics based on its two laws. But there was another method; and it was by this that the theory of dynamics was brought to light—to invent an artificial clock, the action of which could be seen. It was from the actual pendulum that the principles of the constancy of the periods of oscillating and revolving bodies were discovered, whence followed the dynamical theories of astronomy, of light, and of sound.

As regarded the action of heat, no visible mechanical contrivance was discovered which would afford an example of the mechanical principle and motions involved, so that the only apparent method was to discover by experiment the laws of the action of heat, and to accept these as axiomatic laws without forming any mental image of their dynamical origin. This was what the present theory of thermodynamics purported to be.

In this form the theory was purely mathematical and not fit for the subject of a lecture. But as no one who had studied the subject doubted for one moment the mechanical origin of these laws, Professor Reynolds would be following the spirit if not the letter of his subject if he introduced a conception of the mechanical actions from which these laws sprang. This he should do although he doubted if he should have so ventured, had it not been that while considering this lecture he hit upon certain mechanical contrivances, which he would call kinetic-engines, which afforded visible examples of the mechanical action of heat, in the same sense as the pendulum was a visible example of the same principles as those involved in the phenomena of light and sound. Such machines, thanks to the ready help of Mr. Foster, his assistant, in constructing the apparatus, he should show, and he could not but hope that these kinetic-engines might remove the source of the obscurity of thermodynamics on which he had dwelt.

The general action of heat to cause matter to expand was sufficiently obvious and popularly known; also that the expanding matter could do work was sufficiently obvious. But the part which the heat played in doing this work was very obscure.

It was known that heat played two, or it might be said three, distinct mechanical parts in doing this work.

These parts were:—

1. To supply the energy necessary to the performance of work.

2. To give to the matter the elasticity which enable it to expand—to convert the inert matter into an acting machine.

3. To convey itself, *i.e.*, heat, in and out of the matter.

This third function was generally taken for granted in the theory of thermodynamics, although it had an important place in all applications of this theory.

The idea of making a kinetic-engine which should be an example of action such as heat, had no sooner occurred to him than various very simple means presented themselves. Heat was transformed by the expansion of the matter caused by heat.

At first he tried to invent some mechanical arrangement which would expand when promiscuous agitation was imparted to its parts, but contraction seemed easier—this was as good. All that was wanted was a mechanism which would change its shape, doing work when its parts were thrown into a state of agitation.

In order to raise a bucket from a well either the rope was pulled or the windlass wound—such a machine did not act by promiscuous agitation; but if the rope was a heavy one (a chain was better) and it was made fast at the top of the well so that it just suspended the bucket, then if it was shaken from the top waves or wriggles would run down the rope until the whole chain had assumed a continually changing sinuous form. And since the rope could not stretch, it could not reach so far down the well with its sinuosities as when straight, so that the bucket would be somewhat raised and work done by promiscuous agitation. The chain would have changed its mechanical character, and from being a rigid tie in a vertical direction would possess kinetic elasticity, *i.e.*, elasticity in virtue of the motion of its parts, causing it to contract its vertical length against the weight of the bucket. Now it was easy to see in this case that to perform this operation, the work spent in shaking the rope performed the two parts of imparting energy of motion to the chain and raising the bucket. A certain amount of energy of agitation in the chain would be necessary to cause it to raise a bucket of a certain weight through a certain distance, and the relation which the energy of agitation bore to the work done in raising the bucket, followed a law, which if expressed would coincide exactly with the second law of thermodynamics. The energy of agitation imparted to the chain was virtually as much spent as the actual work in raising the bucket, that was to say, neither of these energies could be used over again. If it was wanted to do further work, the raised bucket was taken off, and then to get the chain down again it must be allowed to cool, *i.e.*, the agitation must be allowed to die out; then attaching another bucket, it would be necessary to supply the same energy over again.

He had other methods besides the simple chain, which served better to illustrate the lecture, but the principle was the same.

In one there was a complete engine with a working pump. By mere agitation the bucket of the pump rose, lifting 5lbs. of water 1 foot high; before it would make another stroke the agitated medium must be cooled, *i.e.*, the energy which caused the elasticity must be taken out, then the bucket descended, and, being agitated again, made another stroke.

He felt that there was a childish simplicity about these kinetic-engines, which might at first raise the feeling of "Abana and Pharpar" in the minds of some of his hearers. But this would be only till they realised that it was not now attempted to make the best machine to raise the bucket, but a machine that would raise the bucket by shaking. These kinetic-engines were no mere illustrations or analogy of the action of heat, but were instances of the action of the same principles. The sensible energy in the shaking rope only differed from the energy of heat in the scale from the energy of heat in a metal bar. The temperature of the bar, ascertained from absolute zero, measured the mean square of the velocity of its parts multiplied by the weight per foot of the chain, really represented the energy of visible agitation in the chain.

The waves of the sea constituted a source of energy in the form of sensible agitation; but this energy could not be used to work continuously one of these kinetic machines, for exactly the same reason as the heat in the bodies ot the mean temperature of the earth's surface could not be used to work heat-engines.

A chain attached to a ship's mast in a rough sea would become elastic with agitation, but this elasticity could not be used to raise cargo out of the hold, because it would be a constant quantity as long as the roughness of the sea lasted.

Besides the waves of the sea, there was no other source of sensible agitation, so there had been no demand for kinetic-engines. Had it been otherwise, they would not have been left for him to discover—or had they been, he might have been tempted to patent the inventions. But there had been a demand for what might be called sensible kinetic-elasticity to perform for sensible motion the part which heat-elasticity performed in the thermometer.

And it had been left for him to invent kinetic-mechanism for this purpose. although it might be that its semblance to the thermometer had not been recognised. The principle was long ago applied by Watt. The common form of governors by a steam-engine acted by kinetic-elasticity, which elasticity, depending on the speed at which the governors were driven, caused them to contract as the speed increased. The governor measured by contraction the velocity of the engine, while the thermometer measured by expansion the velocity in the particles of matter which surrounded it; so that it could now be seen that having to perform two operations, the one on a visible scale, the other on a molecular scale, the same class of mechanism had been unconsciously adopted in performing both operation.

The purpose for which these kinetic-engines was put forward was not that they might be expected to simplify the theory of thermodynamics, but that they might show what was being done. The theory of thermodynamics could be deduced by the laws of motion from anyone of these kinetic-engines, just as Rankine deduced it from hypothesis of molecular vortices.

Nothing had been said of the third part which heat employed in performing work, namely, conveying heat in and out of matter. It was an innovation to introduce such considerations into the subject of thermodynamics, but it properly had a place in the theory of heat-engines. It was on this part that the speed at which an engine would perform work depended.

The kinetic-machines showed this. If one end of a chain was shaken the wriggle ran along with a definite speed, so that a definite interval must elapse before sufficient agitation was established to raise the bucket; further, an interval must elapse before the agitation could be withdrawn, so that the bucket might be lowered for another stroke. The kinetic-machine, with the pump, could only work at a given rate. He could increase this rate by shaking harder, but then he expended more energy in proportion to the work done. This exactly corresponded with what went on in the steam-engine, only owing to the use of separate vessels, the boiler, cylinder, and condensers, the connection was much confused. But it was clear that for every H.P. (2,000,000 ft.-lbs. per hour) 15,000,000 ft.-lbs. had to be passed from the furnace into the boiler, as out of the 15,000,000 no more than 2,000,000 could be used for work, the remaining 13,000,000 were available for forcing the heat into the boiler and out of the steam in the condenser, and they were usefully employed for this purpose.

The boilers were made as small as sufficed to produce steam, and this size was determined by the difference of internal temperatures of the gases in the furnaces, and the water in the boiler; and whatever diminished this difference would necessarily increase the size of the heating-surface required, *i.e.*, the weight of the engine. The power which this difference of temperature represented could not be used in the steam-engine, so it was usefully employed in diminishing the size of the engine.

Most of this, which in the steam-engine was at least eight times the power used, was spent in getting the heat from the gases into the metal plates, for gas acted the part of conveyance far less readily than boiling water or condensing steam. If air had to be heated inside the boiler and cooled in the condenser with the same difference of temperature, there would be required thirty or forty times the heating surface—a conclusion which sufficiently explained why attempts to substitute hot air for steam had failed. In one respect the hot air-engines had an advantage over the steam-engine. During the operation in the cylinder the heat was wanted to be kept in the acting substance; this was easy with air, for it was such a bad conductor of heat that unless it was in a violent state of internal agitation it would lose heat but slowly, although at a temperature of 1,000 degrees and the cylinder cold.

Steam, on the other hand, condensed so readily that the temperature of the cylinder must be kept above that of the steam. It was this fact that limited the temperature at which steam could be used. Thus, while hot air failed on account of true economy, the practical limit of the economy of steam was fixed by that which a cylinder would bear. These facts were mentioned because at the present time there appeared to be the dawn of substituting combustion-engines in the place of steam-engines.

Combustion-engines, in the shape of guns, were the oldest form of heat-engine. In these, the time required for heating the expansive agent was zero, while they had the advantage of incondensible gas in the cylinder, so that if the cylinder was kept cool it cooled the gas but slightly, although this was some 3,000 degrees in temperature.

The disadvantage of these engines was that the hot gas was not sufficiently cooled by expansion, but a considerable amount of the heat carried away might be used again could it be extracted and put into the fresh charge; to do this, however, would introduce the difficulty of heating-surface in an aggravated form. However, supposing the cannon to have been tamed and coal and oxygen from the air to be used instead of gunpowder. Thermodynamics showed that snch engines should still have a wide margin of economy over steam-engines, besides the advantage of working with a cold cylinder and at an unlimited speed. The present achievement of the gas-engine, stated to be some 2,000,000 ft.-lbs. per ton of coke, looked very promising, and it was thus not unimportant to notice that whatever the art difficulties might be, thermodynamics showed no barrier to further economy in this direction, such as that which appeared not far ahead of what was already accomplished with steam-engines.

But however this might be, he protested against the view which seemed somewhat largely held that the steam-engine was only a semi-barbarous machine, which wasted 10 times as much heat as it used—very well for those who knew no science, but only waiting until those better educated had time to turn their attenton to practical matters, and then to give place to something better. Thermodynamics showed the perfections not the faults of the steam-engine, in which all the heat was used, and could only enhance the admiration in which the work of those must be held who gave, not only the steam-engine, but the embodiment of the science of heat.

SECONDARY GENERATORS.

A VERY pronounced departure from the ordinary practice of electric lighting has just been inaugurated on the Metropolitan Railway, several stations on which line are now illuminated by means of the Gaulard-Gibbs system of secondary generators. This system was fully described in *The Times* of April 18 last, so that we need only here notice its general features. The invention is based upon the influence of electrical currents upon bobbins of an insulated wire, and in producing their results the inventors have followed the line traversed by Ampère, but with far more important and practical issues. The apparatus used consists of a dynamo-electric machine producing an alternating current, which current is conducted to a secondary generator. Here the insulated primary conductor or main wire is encircled by a series of smaller wires, which are also insulated, and in which the secondary currents are generated. The generator is of columnar construction, and the columns are divided up into groups, and are so connected as to admit the current induced on the secondary conductors, by the influence of the alternating current which traverses the primary conductor, being made to develop different potentials at will—*i.e.*, the different qualities of current required respectively for incandescence lamps, arc lamps, and motive power. An important feature of this system of electrical distribution is that a metallically closed circuit is used to convey the primary current. Hence no limit need be fixed to the electromotive force of the current, which, on such a circuit, is harmless. The currents induced on the secondary conductors alone are utilised for the purposes indicated. The first practical application of the system has been made on the Metropolitan Railway by the National Company for the Distribution of Electricity by Secondary Generators, whose offices are at No. 18, Warwick-street, Regent-street. The generating apparatus is fitted up at the Edgware-road Station of the Metropolitan Railway, and recently at a private view of the installation and were enabled to examine the whole of the arrangements, which worked in a very satisfactory manner. The stations at present illuminated are Notting-hill-gate, Edgware-road, and Aldgate. Other stations are to follow in due course, and they will all be on the same primary circuit, which is about 15 miles in length and only four millimetres in diameter, Notting-hill-gate and Aldgate being something over seven miles apart.

The generating power consists of a steam-engine of 35-horse power running at 120 revolutions per minute, and supplied with steam from a Cornish boiler at 60lb. pressure per square inch. The engine drives through a counter shafting a Siemens W° alternating-current dynamo machine running at 650 revolutions per minute and excited by a small Siemens dynamo running at 1,000 revolutions per minute, the large dynamo giving 16,000 alterations per minute The primary wire is led from the large dynamo to the secondary generator, after traversing which it is led out of the station and along the course of the line at the side of the tunnel to the Notting-hill-gate Station, whence it returns to Aldgate, and thence is led back to Edgware-road, a total length of 15 miles, including bends and turnings at stations. The illumination at the Edgware-road Station consists of two arc lamps and 30 incandescence lamps. One of the arc lamps is placed in the generating station, while the other is suspended from the roof of the passenger station near the bridge. The incandescence lamps are ranged along each platform and are placed in the ordinary globular gas lamps. The booking-office is also effectively lighted by incondescence lamps, which are there seen at their best. At Notting-hill-gate, as at all other stations to be lighted, a secondary generator is placed on the main circuit and the station is illuminated by means of one arc and 20 incandescence lamps, similarly arranged to those at Edgware-road, and, in fact, at the other stations. Aldgate Station is lighted by the aid of 40 incandescence lamps and one arc lamp. There are all the stations at present thus lighted, but King's-cross and Gower-street will shortly follow, the former with 40 incandescence and two arc lamps and the latter with 3[illegible] incandescence lamps and one arc light. It will thus be seen that there are at present 90 incandescence and four arc lamps, but with the two additional stations mentioned there will be 70 incandescence and three arc lamps more, giving a total of 160 incandescence and seven arc lamps. This will absorb all the power the present steam-engine is capable of producing, and to light the remaining stations extra driving power will have to be supplied. As it is, there are now 90 incandescence lamps, mostly of 20-candle power, but some of 40 candle-power, so that they may be taken roundly at 100 lamps of the smaller power. As eight incandescence lamps are equal to one-horse power, and as one arc lamp may be similarly computed, it follows that, there being four arc lamps, there is 16-horse power developed at the lamps. As, however, the engine is stated to be at present developing 22-horse power, it follows that there must be a loss of 6-horse power. This loss is accounted for by friction of the machinery and loss in transmission along the line. It is, however, stated that this loss of 6-horse power is a constant, and that no matter how many lamps are being driven—of course, within the limits of the generating power—no further loss will ensue. We should mention that in the arc lamps Jablochkoff candles are used, while the incandescence lamps are those of Swan, the latter being in all cases fitted in the ordinary station lamps. This is a disadvantage, inasmuch as the flames of the lanterns, which are globular and in sections, cast shadows on the platforms. In other respects the light is very satisfactory, and although the stations do not present the brilliant appearance of those in which the arc light alone is used, and which is sometimes dazzling, there is a mellow light cast around ample for all practical purposes, and presenting a pleasant contrast to that of the gas at the stations on the Metroplitan Railway not yet electrically lighted.

In the Gaulard-Gibbs secondary generators we thus have the solution of a very important problem practically demonstrated. The problem is to rid the user of electric light or power from the necessity of having on his premises a steam engine, boiler, dynamo machine, and the necessary attendants. The solution is the secondary generator placed in his house and connected with a central generating station. The user can himself manipulate the electrical energy with the same facility as he now does gas and water, readily transforming it into current of different natures, and consequently applicable to the various purposes of incandescence and arc lighting and the production of motive power, and all at the same time and from the same primary generating machine, as we have seen demonstrated. There is likewise the important element of safety, for in touching the naked line over which a current of 2,000 volts was stated to be passing no sensation whatever is experienced. After seeing the work done on the Metropolitan Railway it is easy to understand the importance of the services this discovery will render by enabling the distribution of natural forces to be effected at any number of points and over considerable distances.

SOME CURIOSITIES OF STEEL.

Eight master taps, or hobs, were made from the same bar of four-inch steel, each cut to a pitch of three to the inch, each scored, heated, hardened, and drawn to temper at the same time. Six hours after the tempering one of them "exploded," or at least cracked into three pieces, with a report. The fractures give to the trained mechanical eye the appearance of good steel, and show no water cracks or other evidence of previous fracture. At the same establishment where this breaking occurred, one of its most important departments is the production of taps, reamers, dies, and similar tools. It has been abundantly proved that forged taps and reamers are inferior to those made direct from the sized commercial bar, not only in their resistance to torsion, but in the retention of their integrity under the exactions of hardening and tempering; the best taps are those which are turned direct from the bar.

There seems to be a tendency of forged steel, under certain forms, to return to the shape of the original bar. This is shown especially when the forging from a square bar is flattened. Sometimes a flattened piece will curve in the hardening as though its fibres had been stretched, and when relaxed by the heat and again placed under tension by the cooling process, contracted towards the original condensed square form. A singular example was noticed recently. A plug gauge two and five-eighths inches wide and one and three-sixteenths inches thick was forged from a square bar, finished and hardened. After hardening it was to be ground to exact size by a corundum wheel, when the ground side immediately swelled in the centre almost enough to be seen by the unaided eye, but was quite apparent with the straight edge. The other face, from which the skin of hardening had not been removed, remained straight, but as soon as that had not been removed, remained straight, but as soon as that had been ground it acted just as the other did and both the side faces were swelled, and so much so that the increase in thickness by the micrometer gauge was more than one-hundreth of an inch. On treating the edges a contrary result was produced: each edge face became concave, so that when the grinding was completed the plug had two opposite convex sides and two opposite concave edges. The plug was then annealed and redressed to truth; then rehardened and reground with the same results as at first. A second time it was annealed, trued, and then case-hardened, but even then it continued its perversity, and it is to be kept as a curiosity as it is, unless it is decided to saw it in two to inspect its interior.

The most vexatious thing about these "queerities" is that no theory that bears the test of practice has, so far, accounted for them. If the "reason why" could be discovered the causes could be removed and the working of steel be made an exact and certain art. Still, there has been great progress in this direction during the last twenty years; the percentage of loss in hardening and tempering steel has been reduced to a very low figure. These improvements have been owing to the greater uniformity in the character of the steel produced as well as to the greater skill in its after manipulation. We may not despair of yet being able to make the production of hardened steel articles as even and certain as those from any other material.

TINNED FOODS.

The *Medical Times* says that tinned meats, soups, vegetables, and more especially fruits, are all, without exception, contaminated by metals; such is the irresistible conclusions of recent scientific investigation. In 1878, Mr. Albert B. Menke communicated to the *Chemical News* results of analyses of a tin of lobster, one of apples, and another of pineapple; the latter contained tin dissolved in the juice equal to 1·3 grain per pound, the lobster and apples a much smaller quantity. Mr. Hehner in 1880 communicated to the *Analyst* the results of a prolonged and thorough investigation of the subject. He found tin in tinned French asparagus, American asparagus, peas, tomatoes, peaches, pineapples, white cherries, red cherries, marmalade, corned beef (five different brands), ox-cheek, ox-tongue (three kinds), collared-head, tripe, oysters, sardines preserved in oil, salmon, lobsters, shrips, curried fowl (two kinds), boiled rabbit, boiled mutton, roast chicken, roast turkey, soup, and in three brands of condensed milk. The amount of tin found does not appear large—*e.g.*, in the milk one-tenth of a grain per pound, in one of the soups half a-grain per pound, and in a pound tin of preserved oysters seven-tenths of a grain per pound. On a later research, Mr. Wynter Blyth has found far larger quantities. In a recent report to the Vestry of St. Marylebone, detailing the examination of twenty-three samples of tinned apricots, tomatoes, pineapples, and cranberries, the amounts found, calculated as stannous hydrate, range from 1·9 grain to 14·3 grains per pound, the mean amount being 5·2 grains. The juice and fruit in some instances had a metallic taste. Several of the tins showed signs of corrosion. The little that is known of the action of stannous hydrate may be summed up in a few lines. Doses of about ·174 gramme per kilogramme per kilogramme of body weight cause in guinea pigs death with signs of intestinal irritation; but with doses smaller than ·17 to ·2 gramme the effects are uncertain, and the animals generally recover. Hence, supposing a man to be affected in the same proportion, he would have to take from three to four drachms, or consume at a meal 10lb. of the most contaminated of Mr. Wynter Blyth's tinned fruits. But it is not a question of immediate deadliness; it is rather one for inquiry as to the action of small repeated doses continued for a long time.

New Aperiodic Galvanometer.—G. Le Goarant de Tromelin states that the instrument in question has six poles formed by three horseshoe magnets with limbs very close together. These three fixed magnets are placed horizontally, one above the other, at a distance of 0·005 metre. The flame encloses the two poles of the middle magnet, leaving play-room sufficient to permit it to oscillate freely and to obtain 20 degrees of deviation on each side. The wire of this small and very light frame is perpendicular to the axis of the magnets, and the current arrives there by a suspension wire, as in Sir W. Thompson's syphon recorder. If this galvanometer is connected with the two ends of a telephone from which the vibrating plate has been removed, the mere fall of a fragment of iron-filing, weighing a few milligrammes, upon the pole of the magnet of the telephone is sufficient to cause a deviation of the flame.—*Comptes Rendus.*

The Scientific Review

AND

SCIENTIFIC AND LITERARY REVIEW,

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SESSION 1882—1883.

If any meeting be held special notice *per post* will be supplied.

Subscriptions are payable to Mr. G. A. Stretton, the Receiver, 4, St. Martin's-place, S.W., who is the proper official to give receipts.

Proceedings of the Institute.

The Institute being out of session no meetings have been held.

Monthly Notices.

The first meeting of the Royal Society for the approaching session took place on Thursday, November 15th, at 4.30 p.m. The anniversary meeting of the Society was held, as usual, on St. Andrew's Day. The list of Council and officers to be submitted for election is as follows:—President, Prof. T. H. Huxley; treasurer, Dr. J. Evans; secretaries, Prof. G. G. Stokes, and Prof. M. Foster; Foreign secretary, Prof. A. W. Williamson; other members of the Council, Capt. W. de W. Abney, Prof. W. G. Adams, the Duke of Argyll, J. G. Baker, Dr. T. L. Brunton, W. H. M Christie, Astronomer-Royal, Warren De La Rue, Sir F. J. O. Evans, Prof. G. C. Foster, F. Galton, J. W. L. Glaisher, Sir W. W. Gull, Dr. H. Müller, Prof. J. Prestwich, Prof. O. Reynolds, and O. Salvin.

The Institution of Civil Engineers, encouraged by the success which attended the course of lectures delivered last year on "Electricity one of the Great Sources of Power in Nature," has resolved that a course shall be delivered this year on "Heat in its Mechanical Relations." The first lecture will be given by Prof. Osborne Reynolds, F.R.S., on "The General Theory of Thermodynamics."

The Mineralogical Society, at its anniversary meeting, held on October 22nd, in the theatre of the Museum of Practical Geology, elected the Rev. Prof. Bonney, F.R.S., as President, and Dr. S. Houghton, F.R.S., and W. H. Huddlestone, M.A., F.G.S., as Vice-Presidents for the coming session.

The Society of Engineers is now holding its meetings at the Westminster Town Hall, the society having outgrown the limits of its previous meeting-place in Victoria-street; the offices, library, and reading-room of the society are, however, for the present at 6, Westminster Chambers.

Illuminative Power of Gases.—In November last, Dr. Werner Siemens presented to the Berlin Academy of Sciences a paper from which it appears that gases heated to a temperature at which steel begins to melt, do not emit any luminous rays, if proper care has been taken to subject them only to heating and not to chemical action. Dr. W. Hittorf, of Münster, has since then recalled the fact that he made observations of this kind in 1876. When causing the electric spark produced by the 1,600 cells of his battery to pass between two platinum electrodes, he noticed the positive terminal surrounded by a yellow red light and the negative by a blue glow, but the rarefied gas between the terminals was quite dark, although hot enough to melt any metal rod held in it. Dr. Siemens' investigations induced Dr. Hittorf to repeat his experiments, employing two iridium bars (equilateral section with a side of three millimetres and six centimetres long) from the well-known platinum works of Mr. Matthew. These iridium electrodes Dr. Hittorf fixed in strong brass rods and placed them opposite and another in a glass tube six centimetres length. By arranging his powerful battery of 2,000 cells in groups so as to decrease the interior resistance, Dr. Hittorf obtained most beautiful and curious effects, the anode melting, and the cathode maintaining its sharp edges, both however at white heat, whilst the gases—nitrogen, hydrogen, and carbonic acid were experimented with—remained perfectly dark. From these experiments it would follow that wherever a gas is perceived to be glowing, we have to deal with a combustion or other chemical combination, and not with heat effects only; and it has been established by Mr. G. Wiedemann, that the splendid luminous phenomena of the Geissler tubes are of the nature of a phosphorescence, that is to say of a slow combustion.—*Engineering.*

The North Wales College.—The whole of the governing body of the proposed university for North Wales have been elected, and the Earl of Powis, as President of the Executive Committee, has convened a meeting to be held at Chester for the election of a council. Donations of £1,000 have been given by the Duke of Westminster, Lord Penrhyn, Mr. W. Rathbone, M.P., Mr. Richard Davies, M.P., Mr. John Roberts, M.P., and Mr. Hudson. Nothing definite has as yet been settled as regards the site at Bangor. In Montgomeryshire and Merionethshire a movement which is actively supported by Mr. Rendel, M.P., Mr. S. Holland, M.P., and Mr. H. Robertson, M.P., is going on in favour of the continuance of the Government grant of £4,000 to the university at Aberystwyth.

THE SCIENTIFIC REVIEW

AND

Scientific and Literary Review

INCORPORATING THE "JOURNAL OF THE INVENTORS' INSTITUTE."

DECEMBER, 1883.

HEALTH APPLIANCES EXHIBITION.

FOLLOWING the success of the Fisheries Exhibition we are to have next year a Health Appliances Exhibition, and as the latter, although it may not command that universal or picturesque display that the late exhibition gave, yet in another form it should obtain a marked and possibly an increasing interest; seeing that the Fisheries Exhibition, apart from the apparatus and appliances shown in that Exhibition, appealed nearly exclusively to Fishermen, both here, abroad, and in our colonies; whereas the forthcoming Exhibition will commend itself not only to those on the seaboard, but to a great extent to large cities and towns, for a purpose, amongst others, of purifying, if such a word may be used, the great cities and towns of the world.

We have heard of late a great deal of the Outcasts of London, or, if a more proper term be used, the slums in which they live. That there are places horrible to contemplate in every part of this great city of London, as an example, which could be coped with by our sanitary authorities is patent. But the difficulty to contend with, as put forward by a correspondent in a daily paper, is the difficulty of housing the poor before proper accommodation be obtained in the event of their being turned out of their present abodes.

Another phase of this question seems to have been in part overlooked, and that is the small buildings which are now being run up in all parts of the outskirts of the metropolis. On what foundation do the majority of these houses rest? Filth and rubbish which is shot into the pit first made, from which is taken either the gravel, sand, or clay as the case may be. Here the Sanitary Engineer is taken at a disadvantage, for how can he act with such a house and give it a wholesome character when he has to contend with such an enemy as the filth on which the house rests. Again, as regards the house (?) itself, a vast number of them now built and in progress have no good sanitary arrangements or appliances, the only consideration of a majority of these speculative builders being to run up a kind of house the exterior of which shall look very nice, but which the tenant will find after a short time to be a house made, as it were, of cards.

These are difficulties the honest Sanitary Engineer and those desirous of building a substantial house or cottage have to contend against, and till something is done by the Legislature tending to more efficient Sanitary Inspection by the local officers appointed for that purpose the efforts of our philanthropists anxious to improve and elevate the masses will have very poor results. Therefore we say have efficient and energetic officers, not only to look after present buildings, but also to see the initial and first stage of cleanliness enforced, viz., houses built on virgin soil and not rubbish, such houses being constantly inspected during erection, so that the house and its sanitary arrangements be properly carried out.

If the forthcoming Exhibition will in any degree effect results that are desired it accomplishes that which will clear away many of the difficulties that at present beset the unwary in the matter of obtaining a substantial residence, which from the present state of building, without personal or professional inspection, is out of the question.

With this point in view the first and essential consideration is the foundation, and then, as the house or houses progress, a periodical inspection by competent officials, who would be answerable for the proper construction of the house and the sanitary and other appliances connected therewith.

Value of Wheat-bran for Human Diet.—Dr. Max Rübner says the finest flour represents only 30 per cent of the grain of wheat; the medium qualities about 70 per cent. Comparative experiments were tried with bread made respectively from such flours and from the wheat-meal of the Bread Reform League. The larger the proportion of bran left in the flour the more nutritious matter remains unassimilated, and is excreted. The author considers that bran might be made more assimilable by being more finely ground. He doubts, however the economy of the proposal, since at present bran serves for the food of animals which are able to digest and assimilate it much more completely.

Proceedings of Societies.

ARCHÆOLOGICAL INSTITUTE.

Nov. 1.—The Earl Percy, President, in the chair.—In taking his place for the first time as President of the Institute, and on opening the new session, the Chairman spoke of his desire to follow in the steps of his predecessor, Lord Talbot de Malahide, and to consult, as he did, the best interests of the Institute. While he congratulated the members upon the success of the Lewes meeting, he had much pleasure in knowing that the next annual rendezvous would be at Newcastle-on-Tyne, and he could assure them of a hearty welcome in that city, as well as in his own county, which was so replete with objects of antiquarian interest. He regretted much that Mr. Hartshorne had resigned his position at the Institute, but he trusted that the Society would continue in other ways to have the benefit of his experience and advice.—Mr. J. T. Irvine sent a a paper "On Recent Discoveries in the Central Tower of Peterborough Cathedral," calling attention to Roman and Saxon architectural remains of a remarkable character which had been brought to light. A Roman tile of a peculiar form, like the seat of a modern chair, incribed LEG IX HIS, was spoken of as having been found at Barnack, and lately deposited in the Natural History Museum at Peterborough.—The Baron de Cosson read a paper of much interest upon gauntlets, ranging from the fifteenth to the early part of the seventeenth century, and illustrated his remarks by a collection of upwards of forty examples, lent for exhibition by Mr. F. Weekes, Mr. S. Lucas, the Baron himself, and others. The development of the gauntlet from the simple mail pouch for the hand, of the time of Richard I., to the elaborate and beautiful workmanship of the gauntlet of the early part of the sixteenth century, was further explained by reference to a series of full-size drawings, and to monumental effigies and brasses. Perhaps the most interesting feature of the exhibition were certain left-handed gauntlets, which were cleverly shown to be part of the equipment of duellers in the sword and dagger conflicts so usual in Italy in the sixteenth and seventeenth centuries.—The Rev. J. Beck exhibited a small collection of watch-cases, showing different examples of old shagreen, and horn painted with foliage and pastoral subjects; and a quantity of "watch-cocks" or verge covers,—objects of silver and brasswork of the greatest delicacy and beauty, which have only lately attracted the attention of connoisseurs.—Mr. Hartshorne exhibited a smaller collection, and it was observable that no two examples were alike.

LINNEAN SOCIETY.

Nov. 1.—Mr. F. Crisp, Treas, and V.P., in the chair.—Messrs. T. E. Gunn and A. Hutton were elected Fellows.—A donation to the Society of several interesting letters of Linnæus (1736-1769) to G. D. Ehret, F.R.S., an eminent botanical artist of the last century, was announced by the Chairman.—A paper was read "On the Changes of the Flora and Fauna of New Zealand," by Dr. J. M. Curl. He referred more particularly to the district of Rangitikei, and to the alterations of the aspect of the vegetation within the last forty years. He likewise records his own experiments in the cultivation of trees, shrubs, and flowering plants introduced from widely different climes, remarking that while a few fail to grow with vigour, the majority by degrees adapt themselves to the altered conditions, and many valuable economic plants thrive accordingly.—Mr. J. Starkie-Gardner read a paper "On *Atnus richardsoni*, a Fossil Fruit from the London Clay of Herne Bay." The species has been described by Bowerbank, and commented on by Carruthers, Ettinghausen, and many other authors who have written upon the plants of the tertiary formation. Originally considered as allied to *Casuarina*, Dr. R. Brown suggested its affinities to the Proteaceæ, a view afterwards upheld by Carruthers and others. Ettinghausen thereafter regarded it as the product of a conifer (*Sequoia*,) and Saporta compared the fruit to that of *Dammara*. Mr. Gardner enters fully into the structural peculiarities of the fossil fruit in question, and satisfactorily demonstrates that it belongs to the Betulaceæ under the genus *Alnus*.—A paper, by Miss G. Lister, was read, "On the Origin of the Placentas in the Tribe Alsineæ of the Order Caryophylleæ." This communication is based on a series of observations on the development of a number of genera and species. She concludes that the capsule in the Alsineæ is developed on essentially the same plan as that of *Lychnis*, the difference in the various genera being merely dependent upon the relative height attained by the carpels on the one hand and by the central axis on the other. This being so, we are bound to admit that, if we accept, as we do, the carpellary origin of the placentas in *Lychnis*, the placentas in the Alsineæ, from *Lagina apetala*, which most resembles *Lychnis*, to *Cerastium triviale*, which most widely differs from it, are also carpellary.

CHEMICAL SOCIETY.

Nov. 1.—Dr. Perkin, F.R.S., President, in the chair.—The following papers were read: "On the Production of Hydroxylamine from Nitric Acid," by Mr. E. Divers. Free nitric acid yields hydroxylamine when treated with tin, zinc, cadmium, magnesium, and aluminium. In the presence of hydrochloric or sulphuric acid the quantity, with tin or zinc, may be considerable. Without a second acid only traces can be detected. The author also discusses the action of nitric acid upon metals, and the constitution of nitrites, in which he considers the metal to be directly united with nitrogen.—"On the Chemistry of Lacquer (*Urushi*)," Part 1., by Mr. H. Yoshida. Lacquer contains a peculiar acid (urushic acid) extracted by alcohol, some gum resembling gum arabic, water, and a peculiar diastatic body containing nitrogen. The lacquer when exposed to moist air at 20° C., dries up into a hard lustrous varnish. This hardening is brought about by the action of the diastase upon urushic acid, the latter being converted into oxyurushic acid.—"On some Compounds of Phenols with Amido Bases," by Mr. G. Dyson. The author has prepared and investigated anilin phenate, toluidin phenate, naphthylamin, phenate, anilin β napthate, toluidin naphthate, rosanilin phenate, xylidin naphthate, rosanilin aurinate, and anilin aurinate.—"On the Alleged Decomposition of Phosphorous Anhydride by Sunlight," by Messrs. R. Cowper and V. B. Lewes. In a paper at the British Association, Southport, the Rev. A. Irving stated that phosphorous anhydride, prepared by passing air over heated phosphorus, is decomposed by sun-light into phosphorus and phosphoric anhydride. The authors find that phosphorous anhydride thus prepared consists of a mixture of phosphoric anhydride, phosphorous anhydride, and phosphorus.

ROYAL INSTITUTION.

Nov. 5.—Sir W. Siemens, Manager and V.P., in the chair.—Mr. J. Coles and Mr. L. Mond were elected Members.—Dr. W. M. Ord was elected a Manager in the room of the late Mr. W. Spottiswoode.

SOCIETY OF BIBLICAL ARCHÆOLOGY.

Nov. 6.—D. S. Birch, President, in the chair.—Mr. Budge read a communication "On the Fourth Tablet of the Creation Series, relating to the Fight between Marduk and Tiamat."—A communication was read by Mr. Pinches on Babylonian art, illustrated by Mr. H. Rassam's latest discoveries.

THE INSTITUTION OF CIVIL ENGINEERS.

At the opening meeting of the session on the 13th of November, Mr. Brunlees, President, in the chair, Mr. G. B. Bruce, vice-president, gave an account of his recent visit to the United States of America as the representative of the Institution, on the occasion of the opening of the through line of the Northern Pacific Railroad. The invitation came from the president and the directors of the Railroad, through Lord Granville, and Mr. Bruce took the place of Mr. Brunlees, President of the Institution, who was unable, through other engagements, to go himself. Invitations were also given to departments of the Government of this and other countries, the representatives of all of which were received as guests of the Company from the time of their leaving Europe until their return. The Railroad is based upon a concession from the Government, the Company making the road, and the Government giving 25,000 acres of land per mile of road constructed, in alternate sections, the Government holding one block and the Company the next. The Railroad lies mainly between the 46th and 47th parallels of North Latitude, about 200 miles south from the boundary between Canada and the States, and 3,000 miles south of the Pacific Railway. The distance between the termini, Lake Superior and Puget Sound, was about 2,200 miles. Besides this, there was a branch from Brainerd on the main line to St. Paul on the Mississippi, which would probably be the chief route for traffic between the Northern Pacific towns and the eastern ports. Proceeding north-westwards from St. Paul, the country at first was chiefly under wheat; some distance after passing the Missouri it was mainly devoted to raising cattle. Mr. Bruce was particularly struck with the bridges on the line. The crossing of the Missouri at Bismarck was effected by an iron bridge 1,450 feet long, having three spans of 400 feet each, and two spans of 113 feet each, and was 50 feet above the highest level of summer floods. The large girders were about 50 feet deep. The majority of the bridges throughout the road were of timber, the most remarkable being among the Rocky Mountains. Here, too, were the steepest gradients on the line, the maximum being 116 feet to the mile. The crossing of the summits of the two ranges would be by two tunnels, each 1,200 yards long: at present temporary roads had been laid over the mountains: Mr. Bruce considered the passage of the Columbia River through the Cascade Range the most imposing feature of the line. The road at this point, for a considerable distance, is carried along a ledge made by blasting away the almost perpendicular hill-side into the river below. The rails were of steel, 56 lbs. to the yard; the roads were well sleepered and reasonably ballasted; and there were all the elements of a good and substantial road, which in time will doubtless rank among the best in the United States. There was no signalling apparatus, but great use was made of the telegraph. In one feature the American engineers seemed to be particularly distinguished, namely, in the arrangement of their work, and in the strictly systematic manner in which they carried it forward under very difficult and trying circumstances. The visitors were conducted in four trains of about ten Pullman carriages each. They all left New York and were ready to start from Chicago on the 1st of September. They met with a hearty reception at the cities of St. Paul and Minneapolis which, though not forty years old, each contain a population of between 80,000 and 90,000, and are the centres of large industries. Notwithstanding the lack of timber over many hundreds of miles in the centre, the discovery of coal in that very locality would make it easy to supply the engines with fuel. The Westinghouse brake seemed to be in general use in America. The whole trip was carried out with very few mishaps; one or two slight accidents were the outcome of the running together of carriages from different lines the couplings of which did not correspond. The great ceremony of the occasion was driving the last spike at the "Garrison" Station, at the foot of the eastern side of the Rocky Mountains, when about half-a-mile of track was laid in about half-an-hour.

Mr. Bruce then alluded briefly to some things not connected with the Northern Pacific Railroad. He was struck with the much greater use made of the Electric Light in America than in England. In many little cities in the prairies, a high pole in the middle of the town with a light on it illuminated the whole place. He very much admired the steam-boat accommodation in the United States, and remarked that the arrangements for landing in Liverpool in a steam-tug without even a covering to keep off the rain, contrasted most unfavourably with it, and were a disgrace to our country and to the Companies which perpetuated them. While at Chicago, Mr. Bruce went to see the new works of the Pullman Car Company. There was now there a town of 7,000 inhabitants, where three years ago there was nothing but an unoccupied stretch of country. The chief feature was in the surroundings of the works; everything had been done for the welfare and comfort of the workmen, and the whole had been a great financial as well as moral success.

In conclusion, Mr. Bruce stated that he had been greatly impressed with the extraordinary hospitality of the American people. In Portland, Oregon, for instance, where there are few hotels, the members of the party were received in the same way. We always knew that America was a great and magnificent country; great and magnificent in the extent of its territory; great and magnificent in what it has achieved in the past; great and magnificent in the future which lies before it. We knew all this upon ample testimony, because we had been told it by others and had read of it in books for ourselves. But it required us to cross the Atlantic, to brave all its storms and visit America as the guests of Mr. Villard and the Northern Pacific Railway Company, and the guests of the towns and cities along its route, in order to know, as we now most thoroughly do, that America is great and magnificent even in its hospitality.

Sir James Hannen, Mr. Holms, M.P., and General Hutchinson, R.E., having offered some additional observations, a vote of thanks was, on the motion of the President, passed to Mr. Bruce by acclamation, for devoting so much valuable time and undertaking so long a journey in the interests of the Institution, as well as for the narrative he had just given.

THE SOCIETY OF ENGINEERS.

THE second ordinary meeting of this society for the present session was held on Monday evening, Nov. 5th, at the Westminster Town-hall, where the Council of the society have arranged for the holding of the ordinary meetings in future, the society having outgrown the limits of its previous meeting-place in Victoria-street; the offices, library, and reading room of the society will, however, for the present be at 6, Westminster-chambers. The president, Mr. Jabez Church, M.I.C.E., F.G.S., occupied the chair, and a paper on "The Dundee Street Impovements and Drainage of Lochee," by Mr. Andrew Greig, was read. The following is a synopsis of the paper:—The population of Dundee in 1831 was 45,355, and in 1870 it was 118,900. The assessed rental in those years was £78,821 and £370,728 respectively. The town having thus greatly increased in population, and also in mercantile importance, the police commissioners, who are also the local authority, obtained an Improvement Bill, in 1871, to enable them to take down various buildings, to construct several new thoroughfares, and to drain the suburb of Lochee, &c. The value of the property bought was £395,000. The principal improvements were in the centre of the town, were several streets were widened, and a new street opened up from Seagate to Meadowside, where stands the Albert Institute, containing the free library, picture gallery, and museum. This new street is named Commercial-street, and is the continuation of the street of the same name leading from the docks. Buildings, four storeys in height, and consisting of shops, offices, and dwelling-houses, have been been erected on the greater part of both sides of the street. The style of architecture is Italian, the corner buildings partaking more of the nature of Italian Renaissance, and the general character of the whole being dignified and massive rather than ornate. These streets have been paved with granite and whin setts. Lochee is a suburb of Dundee, and has a population of about 12,000. The area to be drained contained over 500 acres. A large portion of the village lay too low to be drained into the sewers at the north end of Dundee. An outfall was therefore constructed from the west end of Lochee to the sewer in Perth-road, thus bringing the sewer to Dundee. Power was obtained in the Bill to purchase land for sewage utilisation and irrigation purposes, but nothing has yet been done in this matter. The outfall is egg-shaped and built of brickwork in cement. It is two miles 1,252 yards in length, and cost, exclusive of surface damage and wayleave, £6,615 The pipe sewers in Lochee are five miles 386 yards long, and cost £7,506.

ON THE ESTIMATION OF STARCH.

By C. O'Sullivan.

THE following is a resumé of a paper read before the Chemical Society on November 15:—

The author has used the method described below during the last eight or ten years for estimating starch in cereals and malted grain. The method may be briefly described as follows:—The finely ground grain is successfully extracted with ether, alcohol (sp. gr. ·90), and water at 35—38 degs. The starch in the washed residue is gelatinised by boiling with water, cooled to 60 degs. and converted by diastase into dextrin and maltose; if a quantitative determination of these two products be made, the starch originally present can be calculated. The author describes the method as follows:—About 5 grms. of finely-ground flour are introduced into a wide-necked 100 c.c. flask and just saturated with alcohol, sp. gr. 0·82; 20 to 25 c.c. of ether being added. After standing several hours with occasional shaking the ethereal solution is decanted through a filter, and the residue in the flask washed with ether. To the residue there is added 80—90 c.c. of alcohol, sp. gr. 0·90, and the mixture warmed to 35—38 degs. for a few hours; the alcoholic solution is then decanted through the same filter, and the residue washed with alcohol (sp. gr. 0·90) at 35—38 degs. The residue in the flask and on the filter is washed into a 500 c.c. beaker and the beaker filled with water; in about twenty-four hours the solution is decanted through a filter and the residue washed with water at 35—38 degs. The residue in the beaker and on the filter is washed with a short camel-hair brush and a fine jet into 100 c.c. beaker. The whole is then boiled for a few minutes in the water-bath, with constant stirring, to gelatinise the starch, the beaker and its contents are cooled to 62—63 degs, and about 0·03 grm. of diastase added; the digestion at 62 degs. is continued for an hour. The beaker is then boiled for eight to ten minutes; the solution filtered into a 100 c.c. measuring flask; the residue carefully washed with successive small quantities of boiling water, and the whole made up to 100 c.c. at 15·5 degs. The ether frees the grains from fat, &c., the alcohol (0·90) removes the sugars, albuminoids other than casein, &c., whilst water at 35—38 degs. dissolves out the amylams Dextrin and maltose are the sole products of the action of diastase on starch. The diastase is prepared as follows:—Two to three kilos. of finely-ground pale barley malt are mixed with sufficient water to saturate and cover the whole. After standing three or four hours the mass is squeezed with a filter press. If not bright the liquid is filtered. To the clear solution alcohol, sp. gr. 0·83, is added as long as a flocculent precipitate falls: as soon as the supernatant liquid becomes milky the addition of alcohol is discontinued. The precipitate is washed with alcohol 0·86 to 0·88, dehydrated with absolute alcohol, pressed and dried *in vacuo* over sulphuric acid until its weight is constant. Diastase thus prepared is a white, friable, easily soluble powder which retains its activity for a considerable time. Five grms. of barley flour thus treated with 0·03 grm. diastase gave 100 c.c. at 15·5 degs, having sp. gr. 1·01003, which represents 25·39 grms. of solid matter (taking 1·00395 as the sp. gr. of a solution containing 1 per cent of starch products); 9·178 grms. of this solution reduced 0·241 grm. cupric oxide and 200 m.m. of it gave a deviation in the Soleil Wentzke-Scheibler saccharimeter of 21·1 divisions. Thus we have 0·241 grm.+0·7256=0·1748 grm. maltose in 9·178 grms.; in the 100 c.c. or 101·003 grms. there are 1·923 grms. maltose; 1 grm. of maltose in 100 c.c. gives a deviation in 200 m.m. of 8·112 division, and 1 grm. of dextrin in 100 c.c. gives 11·56 div., so 1·923×8·02=15·422, the optical activity of the maltose, and 21·1−15·422=5·678, the optical activity of the dextrin; therefore in 100 c.c. there are $\frac{5{\cdot}678}{11{\cdot}56}=0{\cdot}491$ grms. of dextrin

We have, therefore, in the 100 c.c.—maltose 1·923 grm; dextrin, 0·491 grm.; diastase, 0·03 grm=2·444 grm. out of 2·539 solids as indicated by the sp. gr.; of this deficiency of 0·095 grm., 0·083 proved to be α-amylam which had not been washed out. One part of starch yields 1 part of dextrin, and 1 part of starch yields 1·055 maltose. The starch represented by the above numbers is, therefore, dextrin=0·491, maltose $\frac{1{\cdot}928}{1{\cdot}055}=1{\cdot}822$ or a total of 2·213 grms. of starch from 5 grms. of barley.

Barley thus contains 46·26 per cent o starch, a second experiment gave 46·38 per cent. The author gives many other determinations in detail: Barley malt contains 39·9 per cent; wheat 55·4 per cent; wheat malt, 43·26 per cent and 43·53 per cent; rye, 44—46 per cent; rice, 75·77 per cent; maize, 54—58 per cent; oats, 35—38 per cent. In some experiments the author estimated the starch in a sample of pure starch containing 89·36 per cent of dry starch. He obtained 87·72 per cent and 89·54 per cent. The author states as the result of his experience with the method, that the difference in results obtained by any two observers need not exceed 0·5 per cent of the total starch.

Dr. ARMSTRONG said the paper was one of great value, and the amount of work involved was not by any means represented by the length of the paper. The progress of physiological chemistry must depend upon the accuracy of the means at our disposal of estimating the various constituents. Such researches must contribute a great deal to the investigation of vital problems.

DEATH OF SIR WILLIAM SIEMENS.

We much regret to have to announce the sudden death of Sir William Siemens, which occurred on the evening of Monday, the 18th November, in consequence of an injury to the heart, brought about by a fall a fortnight previously. Walking home from a scientific meeting on the afternoon of Monday, the 15th inst., he tripped and fell while crossing Hamilton Place. Though for a day or two no apparent harm resulted, it was soon found that the heart had been—it was hoped slightly—injured, or, at all events, that the shock, acting on a previously existing morbid condition, had had injurious effects. Still there seemed no reason to fear that rest would not repair the mischief, till on Monday, the 18th November, quite suddenly, the end came.

By his death English science has suffered a severe loss, and a loss which will not readily be made good. At a time when the tendency of science is more and more to specialise itself, and scientific men are often compelled to study one particular branch of a subject alone, it is very rare to find a mind like that of Sir William Siemens, who devoted himself to many distinct branches of science, and yet excelled in them all. Not only has he done much for the advancement of pure science, but it may be said without contradiction that he has, beyond all his contemporaries, promoted the practical application of scientific discoveries to industrial purposes. He was an ardent scientific discoverer, a large and successful manufacturer in at least two distinct branches of industry, an engineer of high rank in the profession, and besides this he was a shrewd and clear-headed man of business.

Charles William Siemens was born at Leuthe, in Hanover, on the 4th of April, 1823. He was educated at the Gymnasium at Lübeck, afterwards at the Polytechnic School at Magdeberg, and finally at the University of Gottingen. Here he studied under Wohler and Himly. In 1842 he became a pupil in the engine works of Count Stolberg, and here he laid the foundation of his engineering knowledge—knowledge he afterwards turned to such good practical account. The fact that he was one of a family of inventors makes it father difficult to say what was the precise personal share he had in the many inventions for which the world is indebted to the four gifted brothers—Werner, William, Carl, and Frederick. They all worked so harmoniously together—the idea suggested by one being taken up and elaborated by another—that it is hardly possible to attribute to each his own proper credit for their joint labour. The task, too, is rendered all the harder by the fact that each brother was always ready to attribute a successful invention to any of the family rather than to himself. It may, however, be said that in electrical discovery the two brothers, William and Werner, were principally associated, while the regenerative furnace is due not only to William, but also to Frederick. It was to introduce to the English public a joint invention of his own and his brother Werner in electro-gilding that William Siemens first came to England. This was in 1843. Speaking two years ago to the Birmingham and Midland Institute, Dr. Siemens, as he was then, gave an interesting and somewhat touching account of the difficulties which not unnaturally beset the young foreign inventor, so ignorant of the language of the country that his first visit was to an "undertaker," under the impression that he was a suitable person to take up and bring out his invention. Thanks to the kindly discrimination of Mr. Elkington, who was able to perceive that certain processes described in some of his own patents could only be carried into effect by the improvements of the Siemenses, he was able to dispose of his invention so far succesfully that he was induced in the following year to come back again on a similar errand. This time it was his "chronometric governor," an apparatus which, though not very successful commercially, introduced him into the engineering world, and was really the cause of his settling in this country. The chief use of this apparatus, intended originally for steam engines, has been found in its application to regulate the movement of the great transit instrument at Greenwich.

His studies in the dynamical theory of heat led him to pay special attention to methods of recovering the heat generally allowed to run to waste in various engineering and manufacturing processes. The first application of these researches was in the regenerative steam engine which he set up in 1847 in the factory of Mr. Hicks, at Bolton. In this superheated steam was employed, but its use was attended with certain difficulties which have prevented the commercial introduction of the invention. The Society of Arts may have the credit of being the first public body in England which recognised the value of the principle by awarding Mr. Siemens a gold medal in the year 1850 for his regenerative condenser. The direction in which he was then working was stated in a paper he read before the Institution of Civil Engineers in 1853 on the conversion of heat into mechanical effect. This paper gained him the Telford Premium and Medal of the Institution. In 1857 William Siemens, in connection with his younger brother and then pupil, Frederick, turned his attention to regenerative furnaces for metallurgical purposes. The regenerative gas furnace, as it is certainly the greatest invention due to the Siemenses, so is the one in which William Siemens is believed to have had the largest share. The first successful application of these furnaces was in 1861. The principle of the regenerative furnace is tolerably well known; it may suffice to say here that its main feature consists in an arrangement by which the waste heat of the products of combination is utilised by being imparted to the air and to the gaseous fuel by which combustion is supported. This is effected by causing the products to pass through chambers in which the heat is taken up by masses of brickwork, and afterwards passing the in-coming currents of air and gas among the heated brickwork. The earlier applications of this principle to steel and glass making have been followed by its extension to many other industrial purposes in which great heat is required, the powers of the furnace being only limited in practice by the nature of the materials of which it can be constructed.

The application of the furnace to the making of iron and steel naturally led the attention of its inventor to other improvements in the same manufacture. In 1862 he endeavoured to reduce to practice the result of Reaumur's experiments in making steel by fusing malleable iron with cast steel. After some years experimenting the Siemens process of steel making was perfected, and a little later still the Siemens-Martin process. In the latter, scrap-iron is melted in a bath of pig-iron on the hearth of the furnace; in the former, ore is reduced. The production of steel in this country under Sir William Siemen's processes was over 340,000 tons in 1881.

But if the inventions of this regenerative furnace and of improved processes for steel making are those which are most likely to keep alive in future years the memory of their inventor, it is just now with the electric light that the name of Siemens is most closely associated in the popular mind. The precise date at which he may be said to have commenced his work in this direction can hardly be given. It was in 1867 that his classical paper on the conversion of dynamical into electrical force without the aid of permanent magnetism was read before the Royal Society. Strangely enough, the discovery of the same principle was enunciated at the same meeting of the Society by Sir Charles Wheatstone, while there is yet a third claimant in the person of Mr. Cromwall Varley, who had previously applied for a patent in which the idea was embodied. It, therefore, can never be quite certain who was the first discoverer of the principle on which modern dynamo machines are constructed. As regards the Siemens discovery, the originator of the idea was Dr. Werner Siemens, who on being shown an electrical motor constructed without permanent magnets, immediately saw that a generator without permanent magnets was equally posssible. The details, however, of the construction of the Siemens machine, and the various improvements by which it has been brought to its present form or rather forms (for there are, of course, several varieties) are due alike to the younger and the elder brother. And the same may be said of the various inventions connected with telegraphy and the electric light which emanated from the great firm of Siemens Brothers. Some of these were entirely worked out by one, some by the other brother, more were the joint production of both, but no attempt was made to separate them or to discriminate. How great were the inventive resources of Sir William is well shown by the saying common in workshops, that as soon as any particular problem had been given up by everybody as a bad job, it had only to be taken to Dr. Siemens for him to suggest half-a-dozen ways of solving it, two of which would be complicated and impracticable, two difficult, and two perfectly satisfactory.

As regards telegraphy the most important work executed by the firm was the laying of the Direct United States Cable in 1874, for which work that remarkable vessel the *Faraday* was built after the designs of Sir William Siemens. A good instance at once of the versatility of Sir William's talents and of his engineering skill is given by the arrangement of the screw propellers in this ship. Their shafts (the *Faraday* is a twin screw) are set at a slight angle, diverging, not outwards, as has often been proposed, but inwards, towards each other. The effect of this is that the thrust of each propeller, when used singly for steering purposes, acts at a much more effective angle, and the result is that the vessel can turn in her own length when the engines are worked in opposite directions. The *Faraday* is most completely fitted up with every possible appliance for cable laying, grappling, and recovering lost cables, but the above small detail is only referred to here as illustrating the way in which Sir W. Siemens dealt with a purely engineering question, which might have been considered quite beside the ordinary direction of his work. To record fitly what he and his firm have done for the advancement, not only of electric lighting, but of the various practical uses of electricity, would involve the enumeration of an infinity of technical details, each comparatively unimportant, each fitting into its own place and serving to produce a complete whole. To enter fully into the amount of electric lighting work effected by them would invite comparisons which at the present moment are above all things to be avoided. It may, however, be said that if a careful examination were made of the working installations of the electric light, it would be found that a very considerable portion of the real work done had been done by the firm of Siemens, Brothers. At the Paris Exhibition they were *facile principes*, at Munich, at Vienna, at the Crystal Palace, they were alike conspicuous. Visitors to the just-closed Fisheries Exhibition will remember how large a share of lighting was effected by Messrs. Siemens. As regards the electrical transmission and conveyance of power, this is a field they have made peculiarly their own. With the exception (and an exception of undoubted importance) of storage batteries, the advances in this direction are principally due to them. The Berlin electric railway and that at Portrush are alike the work of one or other branch of the firm, while those who ever had the pleasure of being shown round his country house near Tunbridge Wells by Sir William can best realise how much he individually did to reduce to human servitude the forces of that mysterious power of which he was so great a master. Not only did electricity perform a large part of the actual work of the farm, sawing wood and pumping water, but it was made to supply in part the place of the sun itself, and assist the growth of plants and fruits. And here we find the practical results of scientific work merging into the researches which have not yet borne their practical effects. Working at the subject of electric light had of late led Sir William Siemens to considerations of the nature of light itself. The tendency of some of these thoughts is shown by certain of recent communications to the Royal Society, including his last paper of all, in April last, "On the Dependence of Radiation on Temperature," and these, again, influenced by his earlier studies on the conservation of energy, led him to one of the most recent of his researches—that which produced his theory of the conservation of solar energy. Almost alone among all the results of his life's work, this theory of his dealt with a question not affecting—or at least not immediately affecting—human welfare. Whether from its novelty, or as emanating from one not claiming to be an authority on the subject, the theory met with not a little sharp criticism when it was first put forward. Had its author lived but a few years longer he would, doubtless, have laboured to strengthen it with yet further observation and argument. As it is, it must remain as a daring and original suggestion, the effort of a keen and sagacious mind to bring to fresh subjects the experience and the knowledge accumulated by work of a totally different sort.

But to turn back again to those practical applications of scientific labour which were the real life-work of the subject of this notice—since without at least some mention of them the memoir would be still more incomplete than it is—almost a bare enumeration must suffice, but at least it will serve to show how varied were the talents we have just lost. The process of "anastatic printing," a process only superseded by recent advances in photographic processes, was due to William and Werner Siemens. It was described by Faraday in 1845. Faraday, too, it may be noted, had for the subject of his last lecture at the Royal Institution the advantages of the Siemens furnace. Improvements in calico printing, the invention of a double cylinder air-pump and of a water metre, are also among the earlier work of William Siemens. Among more recent inventions may be noticed his bathometer, for measuring the depth of the sea without a sounding line, his electrical furnace, his electrical thermometer and pyrometer, his rotatory furnace for the production of iron and steel by the direct process, his deep-sea electrical thermometer, and his regenerative gas-burner.

Sir William Siemens was elected a Fellow of the Royal Society in 1862, and in 1869-70 he served as one of the Council. He became a member of the Institution of Civil Engineers in 1854, and has been on its Council for some years. He was the first President of the Society of Telegraph Engineers, and served a second time in that capacity. He has been President of the Institution of Mechanical Engineers, of the Iron and Steel Institute, and of the British Association. He was Chairman of Council of the Society of Arts, and was to have delivered the opening address of that society's session.

The honours he has received for his inventions and discoveries are very numerous. As above mentioned, the Society of Arts gave him a gold medal for his regenerative condenser in 1850. In 1874 the same society awarded him their Albert Medal for his improvements in metallurgy. At the Exhibitions of 1851 and 1862 he received prize medals, and in 1867 he was awarded a *grand prix* at the Paris Exhibition for his regenerative gas furnace and steel process. The Civil Engineers awarded him their Telford Medal in 1853, and only recently the same institution voted him their Howard Prize. This prize, which is given quinquennially to the inventor of an improved process connected with iron-making, has only been once awarded before, to Sir Henry Bessemer. In 1875 he received the Bessemer Medal of the Iron and Steel Institute. In April last he received the honour of knighthood in recognition of his scientific services. He was honorary member of various foreign scientific societies, and possessed several foreign Orders, among them the Legion of Honour. His contributions to scientific literature have been very numerous. Some of them have been referred to above, others will be found in the record of the Royal Society, the British Association, the Institution of Civil and Mechanical Engineers, the Society of Arts, and other bodies. This brief record may serve to show how valuable was the life that has just passed away, how great the loss of what a few more years of strenuous work might have yielded. Those who knew him may mourn the kindly heart, the generous, noble nature, so tolerant of imperfect knowledge, so impatient only at charlatanism and dishonesty; the nation at large has lost a faithful servant, chief among those who live only to better the life of their fellow men by subduing the forces of nature to their use. Looking back along the line of England's scientific worthies, there are few who have served the people better than this, her adopted son, few, if any, whose life's record will show so long a list of useful labours.—*The Times.*

DECISIONS RELATING TO PATENTS.

The Commissioner of Patents in the United States holds that although a party may be first to conceive and embody an invention in practical form, where it appears that his invention was laid aside, lost sight of, forgotten, and abandoned, and other means adopted for securing the same result, he forfeits his right in favour of a subsequent and independent inventor. His original efforts must be regarded as an abandoned experiment, and cannot be revived after the subsequent invention of the same device by another.

On an appeal from the Primary Examiner the Commissioner has decided that two independent inventions cannot lawfully be included in one application for a patent. The law contemplates that a patent shall be granted for each distinct and independent invention, not for a multiplicity of inventions. In a case where there can be no question that there are two independent inventions embraced in the application within the meaning of the patent law, to grant a patent covering both would be a violation of duty on the part of the officer granting the patent and a violation of the law when it was granted. It is possible that the court would sustain the patent if granted, if there was any doubt as to whether the matter covered by the patent was a single invention; but if it was clear that two distinct inventions were embraced in the patent, not dependent upon each other, I have no doubt that the court would hold such a patent invalid, and the patentee remediless thereunder. With such view of the law but one course can be taken. Applicant must divide his application as required by the Examiner, and if he desires to cover both inventions by patents embrace them in separate applications.

THE CANNON, THE STEAM ENGINE, MAN, AND THE INSECT CONSIDERED AS MECHANICAL MOTORS.

Under the above title we give a *resumé* of some very curious and interesting information published in a recent work of Mr. E. Jouffret, entitled "Introduction to the Theory of Energy."

These examples, which are submitted in a simple and clear way, are well calculated for disseminating a knowledge of the phenomena of conservation and transformation of energy, by presenting them under a concrete form accessible to all those who are not making a special and continued study of them.

A 100-ton cannon (Italian model of 1879) costs 400,000 francs. It requires a 250 kilogramme charge of powder, and throws a projectile weighing 917 kilogrammes with an initial velocity, at the mouth of the cannon, of 523 metres per second.

The energy possessed by the projectile, in the form of live powder, is 12,772,000 kilogrammetres.

The energy represented by one kilogramme of powder is, according to Noble and Abel, 300,000 kilogrammetres, or 75,000,000 kilogrammetres for the charge of 250 kilogrammes.

The *cannon*, considered as a machine, converts them into work *seventeen per cent* of the total energy of the combustion of the powder. This figure is higher than that furnished by the best steam engines, as these convert into work less than ten per cent of the total energy represented by the coal.

It is the animal machine in which the performance is the highest, and this fact may be established in a particular case, as follows:—

According to the *Guide Joanne*, the ascent of Mont Blanc, starting from Chamounix, is effected in seventeen hours, resting spells not included. The difference of level is 3,760 metres. A person ascending who has a mean weight of 70 kilogrammes, produces then, in order to rise, a work of $3{,}760 \times 70 = 263{,}000$ kilogrammetres. This work is borrowed from the heat that the carbon and hydrogen contained in the food eaten disengages upon being burned in the lungs. For the sake of simplicity, if we reduce the entire energy to a combustion of carbon, and recall that a kilogramme of the latter furnishes 3,000,000 kilogrammetres, we find that the 263,000 kilogrammetres represented by the ascent correspond to a consumption of 94 grammes of coal—a consumption that comes to be added to the normal rations necessary for the operation of the organs during a state of rest. Such consumption is 8·35 grammes per hour, or 142 grammes for the seventeen hours. The total consumption of coal is 256 grammes, representing 708,000 kilogrammetres. The performance then is,

$$\frac{263{,}000}{708{,}000} = 37 \text{ per cent}$$

The performance of the human machine drops to 21 per cent when we consider a period of twenty-four hours composed of ten hours of work and fourteen of rest, and a mean daily work of 280,000 kilogrammetres.

The cannon, considered as a machine, is incomparably superior to the steam-engine as regards the time necessary to produce a given quantity of mechanical work.

Thus, for example, the 100 ton cannon developes in *one-hundredth of a second* a quantity of work equal to that which would be yielded by a 47 horse power steam engine *in one hour.* A man of average strength is still lighter than an ordinary steam engine of equal power, but he is much inferior to the other animals of creation, and particularly to insects.

Thus, for example, the libellula, which is capable, without apparent fatigue, of following a train of cars for several hours, giving its wings during this whole time some thousands of backward and forward motions per second, is a hundred times lighter than a steam engine capable of producing an equivalent work.

This is what renders the problem of aerial locomotion so difficult, and, as Mr. Hirn says, it explains why we can fly in imagination only.—*La Nature.*

POLISHING AND PRESERVING PARQUET FLOORS.

THE finish and care of hardwood or parquet floors has been and is now a source of great trouble and annoyance to housekeepers, except in cases were the owners have taken the trouble themselves to look the matter up, or have instructed their architects to be particular about that item. It is too bad that where beautiful floors have been laid, in so many cases they have been left to be finished by persons who have not troubled themselves with finding out the best method of finishing. The usual way for such persons to do is to treat them with shellac or varnish, which is all wrong, as a moment's thought will convince any one that a surface that is constantly walked over needs something different to the coating of gum that is left on the surface after the spirit used in dissolving the shellac or varnish is evaporated.

This coating becomes then, brittle, and is ground up into minute particles by the nails in the boots, and swept away, leaving the wood bare where it is most exposed to view. As a matter of course, the beauty of the floor is soon gone, and instead of being an attractive part of the furnishing, the sanitary consideration very often is about all that keeps one from nailing a carpet over the whole floor. Others use linseed oil, and everybody knows that an oil finish is one of the best methods of finishing wood, but the objection to that method is that each time the oil is applied it darkens the wood, and in a short time the different kinds of wood are of the same colour. Now the question arises, Which is the true and only way of finishing floors properly? and the answer is, by the use of hard wax, which, however, must be so prepared that the trouble of applying it, and the stickiness attending ordinary beeswax and turpentine, are entirely obviated. The wax is treated with special liquids and made into a preparation.

The writer has tried many things and found this hard wax to be the most satisfactory in its results. It is so simple, that when once the floor has been properly filled and finished with it, any servant can renew and keep the floors fresh and bright as long as the wood lasts, and it does not materially change the colour—the wood always retains its beauty. An application about once a year is all that is necessary, if the floors are rubbed over when a little dull, with a weighted brush or cloth. In repolishing old floors that have been in use for a length of time and become dull looking, it is only necessary after they have been cleaned to rub in a thin coat of the hard wax finish with the brush or cloth as stated before. If the floors have been varnished and the varnish is worn off in places, as mentioned above, the best way is to have the varnish scraped off, and then a thin coat of the hard wax should be applied and treated as the new wood after it is filled. But if it is inconvenient to have the floor scraped, or the expense too much, the main object being to restore the colour in those places which are worn and defaced, the following mixture is recommended: One part linseed oil, one part liquid drier, and two parts turpentine. A cloth should be dampened with this and applied to the worn and defaced places, which will have the desired effect. After being wiped off clean it ought to dry twenty-four hours, and then polished with the hard wax finish. It is very important never to use the wax over oil that is not thoroughly dry, as the floor would invariably be sticky. Finally, it would be well to mention that hard wood or parquet floors should never be washed with soap and water, as it raises the grain and discolours the wood.

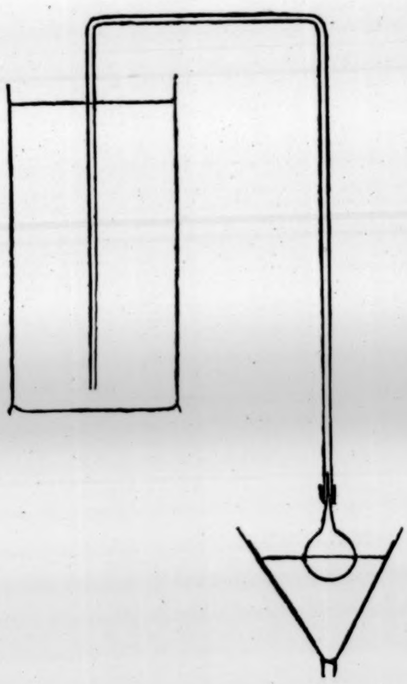
After the floors have been properly filled and finished with the hard wax, dirt will not get into the pores, but stays on the surface, and consequently can be removed with a brush or cloth; or, if necessary, dampen cloth with a little turpentine. This will take off any stain from the finish—*Decorator and Finisher.*

AUTOMATIC FILTRATION.

THE following method of automatic filtration has been devised by Mr. E. E. Robinson:—

When large quantities of liquids, such as reagents, have to be filtered in the laboratory, it is often convenient to have some means by which the filter is kept filled. The usual "bird fountain" which is applicable in some cases has the disadvantage of requiring the inverting of large bottles or flasks filled with liquid, and besides this it does not maintain the liquid at a constant level in the filter.

The following apparatus has been found more convenient:—



To the longer limb of a syphon is attached a short piece of india-rubber tube projecting a little beyond the tube, the india-rubber is closed by the narrow conical stem of a small glass globe which floats on the surface of the liquid in the funnel; when the liquid rises to a certain height the float is lifted, and stops the flow of the liquid, the narrow stem on the float which passes some distance into the syphon acting as a guide.

The apparatus keeps the liquid in the funnel at a constant level, and may be left without attention until the filtration is complete.

MADRID EXHIBITION.—The well-known firm of Robert Daglish and Co., St. Helen's Foundery, Lancashire, have been awarded "Honourable Mention" for photographs of their Gold Reduction Machinery. This is certainly satisfactory for mere drawings; had the machinery itself been exhibited it would have had a gold medal awarded.

DETECTION OF CARBON DISULPHIDE.

By M. VITALI.

THE author fills a gasometer with pure hydrogen, which he allows to traverse a series of U-tubes, filled with fragments of glass or pumice steeped in lead nitrate, silver nitrate, and caustic potassa. For the same purpose may be used fragments of pumice steeped in sulphuric acid and in potassium permanganate. The liquid in which carbon disulphide is to be sought is introduced into a three-necked bottle connected to a second bottle containing tartar-emetic. A current of pure hydrogen is made to pass into the former, and then into the latter. The hydrogen is then conducted into a chloride of calcium tube, after which it may be treated with reagents, or the products of its combustion may be examined. In a first trial we receive the gas in a few c.c. of an alcoholic solution of caustic potassa, to which are afterwards added a very small quantity of neutral ammonium molybdate and a small excess of dilute sulphuric acid. If the liquid contains traces of carbon disulphide, it takes a rose colour, which then passes to a vinous red. Another portion of the gas is passed into a small volume of an alcoholic solution of lead acetate, to which are added a few drops of caustic potassa, and the mixture is heated to a boil. If the mixture contains carbon disulphide, lead sulphide is produced. If the quantity of carbon disulphide is large it becomes sensible to the smell. The flame has a blue centre, and gives off the odour of burnt sulphur. It decolourises blue starch-paper, blue starch-paper charged with iodic acid, produces a yellow spot upon porcelain, which, if treated with caustic potassa and then with sodium nitro prusside or lead acetate, gives the reactions characteristic of the presence of sulphur. If a plate of silver is used instead of porcelain there appears a black spot of silver sulphide. If there are dropped upon the porcelain plate, solutions of caustic potassa, of lead acetate, cadmium sulphate, antimony chloride, or arsenious acid, and the flame is allowed to spread over these points of the plate, the characteristic colours of the metallic sulphides appear. If carbon disulphide is mixed in more or less considerable quantities with solid matters, they are divided as finely as possible, distilled along with water acidulated with sulphuric acid, and the distillate is further examined as above. If it is required to detect carbon disulphide in lighting-gas, the gasometer is filled with this gas, and the process is conducted as described.

Panary Fermentation.—G. Chicandard concludes that panary fermentation does not consist in a hydratation of starch followed by alcoholic fermentation. It is not determined by a *Saccharomyces.* The fermentable matter is the gluten which is rendered available for the microbia by means of a zymase which they secrete. This zymase renders it at first soluble, and then converts it into a peptone by hydration. The microbia assimilate this peptone, furnishing numerous products of excretion, carbonic, acetic, butyric, and lactic acids, hydrogen, nitrogen, alcohol, leucine, tyrosine, and phenol. Crude starch is not modified, either by the microbia or by their zymase; baking alone forms soluble starch, erythro-dextrines, and achroo-dextrines. These latter are found especially in the parts which have been most strongly heated. The agent of panary fermentation exists normally in the grain of wheat as a mobile sphœro-bacterium, *Microzyma glutinis.* It develops into *Bacillus glutinis*, and this change is accelerated by the soluble albumenoid matters which baker's yeast contains. Panary fermentation is produced whenever flour mixed with leven or yeast is brought in contact with water.

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